UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2012/2013 Academic Session

June 2013

EBB 316/3 – Corrosions & Degradation
[Kakisan & Degradasi]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of SEVEN questions. THREE questions in PART A and FOUR questions in PART B.
[Kertas soalan ini mengandungi TUJUH soalan. TIGA soalan di BAHAGIAN A dan EMPAT soalan di BAHAGIAN B.]

Instruction: Answer **FIVE** questions. Answer **ALL** questions from PART A and **TWO** questions from PART B. If a candidate answers more than five questions only the first five questions answered in the answer script would be examined.
*[**Arahan**: Jawab **LIMA** soalan. Jawab **SEMUA** soalan dari BAHAGIAN A dan **DUA** soalan dari BAHAGIAN B. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

The answers to all questions must start on a new page.
[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

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PART A / *BAHAGIAN A*

1. [a] For a concentration cell, briefly describe why corrosion occurs at that region having the lower concentration.

Bagi suatu sel kepekatan, perihalkan secara ringkas mengapa kakisan berlaku pada kawasan dengan kepekatan yang rendah.

(10 marks/*markah*)

[b] For galvanic cell $Sn_{(p)}I\ Sn^{2+}\ II\ Pb^{2+}IPb_{(p)}$, calculate:

(i) EMF and ΔG value of this galvanic cell

(ii) E_{cell} if $[Sn^{2+}] = 0.0010$ M and $[Pb^{2+}] = 1.0$ M

(iii) E_{cell} if $[Sn^{2+}] = 1.0$ M and $[Pb^{2+}] = 0.001$ M

Given: $V^o_{sn} = -0.136$ V

$V^o_{Pb} = -0.126$ V

From (ii) and (iii) write a conclusion from that reaction.

Bagi sel galvani $Sn_{(p)}I\ Sn^{2+}\ II\ Pb^{2+}IPb_{(p)}$, kirakan:

(i) Nilai EMF dan ΔG untuk sel galvanik ini

(ii) E_{cell} jika $[Sn^{2+}] = 0.0010$ M dan $[Pb^{2+}] = 1.0$ M

(iii) E_{cell} if $[Sn^{2+}] = 1.0$ M dan $[Pb^{2+}] = 0.001$ M

Diberi: $V^o_{sn} = -0.136$ V

$V^o_{Pb} = -0.126$ V

Daripada (ii) dan (iii) tuliskan kesimpulan daripada tindakbalas yang berlaku.

(50 marks/*markah*)

[c] With appropriate examples, briefly explain the degradation behavior of polymeric and concrete materials.

Bersama contoh-contoh sesuai, terangkan secara ringkas kelakuan degradasi bahan polimer dan konkrit.

(40 marks/*markah*)

2. [a] Draw and label a saturated calomel electrode (SCE).

Lukis dan labelkan elektrod kolomel tepu (SCE).

(20 marks/*markah*)

[b] A rod of pure zinc (99.9%) sample (diameter 100 mm and length 1500 mm) was sent by AAM Metal Sdn Bhd to you for a closed circuit current measurement in potassium hydroxide (KOH) solution. Explain to them what are the procedures you will make for:

Satu rod zink tulen (99.9%) sampel (diameter 100 mm dan panjang 1500 mm) telah dihantar oleh AAM Metal Sdn Bhd kepada anda bagi pengukuran arus litar tertutup dalam larutan kalium hidroksida (KOH). Jelaskan kepada mereka apa prosedur yang anda akan buat untuk:

(i) Sample preparation.

Penyediaan sampel.

(20 marks/*markah*)

(ii) Your experimental setup (label and explain each components).

Persediaan eksperimen anda (label dan terangkan setiap komponen).

(30 marks/*markah*)

(iii) The expected results.

Keputusan yang dijangkakan.

(30 marks/*markah*)

3. [a] A sacrificial magnesium anode is attached to a steel underground pipeline. It is estimated an average current produced by the anode is 2.02 A. If this anode is completely corroded in 100 days, what is the estimated weight of magnesium that is supposed to be used? (Mg = 24.31 g/mol, F = 96,500 A.s/mol).

Sebatang anod korban magnesium telah dipasang pada paip keluli di bawah tanah. Ia dijangka menghasilkan arus purata 2.02A. Jika anod tersebut akan habis dikakis dalam 100 hari, apakah berat magnesium yang sepatutnya digunakan? (Mg = 24.31 g/mol, F = 96,500 A.s/mol).

(25 marks/*markah*)

[b] Rust is associated with degradation of iron-based structures. The prevention or minimizing the occurrence of rust is the basis of major economic activities nowadays. Discuss the following approaches which could be used to minimize rusting. Give one example for each of the corrosion prevention approaches.

Karat adalah disebabkan degradasi struktur yang berasalkan besi. Justeru itu, pencegahan pengaratan besi ialah aktiviti-aktiviti ekonomi yang utama pada masa kini. Bincangkan pendekatan berikut yang boleh digunakan untuk mengurangkan pengaratan. Berikan satu contoh untuk setiap pendekatan pencegahan kakisan yang dibincangkan.

(i) Galvanization.

Penggalvanian.

(15 marks/*markah*)

(ii) Cathodic protection.

Perlindungan katod.

(15 marks/*markah*)

(iii) Coating and painting.

Penyalutan dan pencatan.

(15 marks/*markah*)

(iv) Inhibitors.

Perencat.

(15 marks/*markah*)

(v) Design of the structures.

Rekabentuk struktur.

(15 marks/*markah*)

PART B / *BAHAGIAN B*

4. [a] The leaf spring for an automobile are formed from high carbon steel. For best corrosion resistance, should the spring be fabricated by hot working or cold working? Explain your answer.

Pegas daun sebuah kereta diperbuat daripada keluli karbon tinggi. Bagi mendapatkan rintangan kakisan terbaik, adakah spring perlu difabrikasi dengan kaedah kerja panas atau kerja sejuk? Terangkan jawapan anda.

(40 marks/*markah*)

[b] For galvanic corrosion, point out which of these two conditions is more favourable for a corrosion prevention and why?

(i) large cathode and small anode.

(ii) small cathode and large anode.

Bagi kakisan galvani, tentukan manakah antara dua keadaan ini sesuai dari sudut pencegahan kakisan dan kenapa?

(i) katod besar dan anod kecil.

(ii) katod kecil dan anod besar.

(30 marks/*markah*)

[c] The fatigue life of a component is significantly reduced when the component operates in corrosive environment. This phenomenon is called corrosion fatigue. Discuss two (2) major factors that influence crack propagation during corrosion fatigue.

Hayat lesu suatu komponen secara signifikannya berkurangan apabila komponen digunakan dalam persekitaran mengakis. Fenomena ini dipanggil kakisan lesu. Bincangkan dua (2) faktor utama mempengaruhi perambatan retak ketika kakisan lesu berlaku.

(30 marks/*markah*)

5. [a] With approriate diagrams, explain the reason for different corrosion behaviour of passive metal in

(i) active region.

(ii) passive region.

(iii) transpassive region.

Menggunakan lakaran yang sesuai, huraikan alasan mengapa bagi logam pasif, kelakuan kakisannya adalah berbeza di dalam

(i) kawasan aktif.

(ii) kawasan pasif.

(iii) kawasan transpasif.

(50 marks/*markah*)

[b] With two (2) examples, describe the effect of metallurgical factor that may influence corrosion problem for metallic material.

Menggunakan dua (2) contoh, huraikan faktor metalurgi yang mungkin mempengaruhi masalah kakisan bagi bahan logam.

(30 marks/*markah*)

[c] A copper electroplating process uses 15 A of current by chemically dissolving a copper anode and electroplating a copper cathode. If it is assume that there are no side reaction, calculate, how long will it take to corrode 9.5 gm of copper from the anode.

Given:

Faraday's constant = 96,500 C/mol or 96,500 A.s/mol

Molecular weight copper = 63.5 g/mol

Proses elektrosaduran kuprum menggunakan arus 15 A melalui pelarutan secara kimia anod kuprum dan elektrosaduran pada katod kuprum. Jika diandaikan tiada tindakbalas sampingan, kirakan berapa lama masa diambil untuk mengakis 9.5 gm kuprum daripada anod

Diberi:

Pemalar Faraday = 96,500 C/mol atau 96,500 A.s/mol

Jisim molekul kuprum = 63.5 g/mol

(20 marks/*markah*)

6. [a] Explain how is pitting related to passive film?

Terangkan bagaimana bopeng berkaitan kepada filem pasif?

(20 marks/*markah*)

[b] Based on your knowledge about potentiodynamic polarization, explain an experiment to produce passive film.

Berdasarkan pengetahuan anda tentang polarisasi potentiodinamik, terangkan satu eksperimen untuk menghasilkan filem pasif.

(40 marks/*markah*)

[c] Explain the 'critical pitting potential'. (Note: use log I vs. E to help your explanation).

Terangkan 'keupayaan kritikal bopeng'. (Nota: Gunakan log I vs E untuk membantu penerangan anda).

(40 marks/*markah*)

7. Corrosion on automobiles causes the metal parts to slowly disintegrate, which can lead to structural failure, leak and a generally unsightly appearance.

Kakisan yang berlaku pada kereta menyebabkan bahagian logam kereta menyepai secara perlahan-lahan. Ini mengakibatkan kegagalan struktur, pembocoran dan kerosotan permukaan badan kereta.

[a] Discuss potential causes of corrosion for automobiles body at:

Bincangkan punca-punca yang boleh menyebabkan kakisan pada badan kereta di bahagian:

(i) front and side panels and

panel hadapan dan sisi.

(20 marks/*markah*)

(ii) wheel arches.

gerbang roda.

(20 marks/*markah*)

[b] Generally, the car body needs to go through pre-cleaning using hydrocarbon solvent, phosphatizing and painting for corrosion prevention.

Badan kereta perlu melalui proses pra-pembersihan dengan menggunakan pelarut hidrokarbon, pemfosfatan dan pencatan untuk pencegahan kakisan.

(i) Discuss the objective(s) of each of these steps

Bincangkan objektif untuk setiap langkah

(10 marks/*markah*)

(ii) How do these steps assist in corrosion prevention of automobiles body?

Bagaimana setiap langkah ini membantu dalam pencegahan kakisan pada badan kereta?

(30 marks/*markah*)

[c] Discuss two (2) corrosion tests which are commonly used by car manufacturers.

Bincangkan dua (2) ujian kakisan yang biasanya dijalankan oleh kilang pembuatan kereta.

(20 marks/*markah*)

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